Arc Flash Hazard and Electrical Safety

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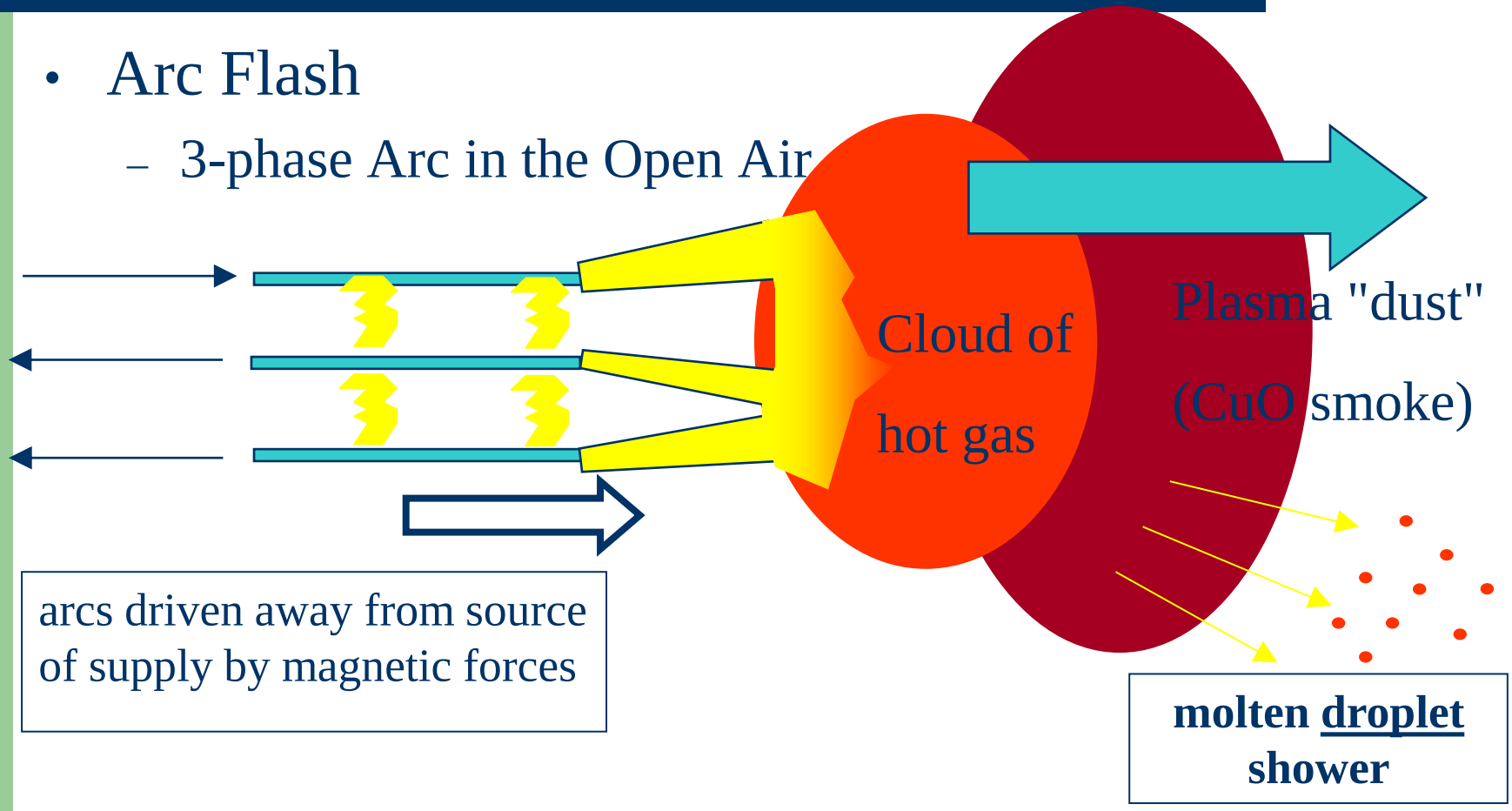
Introduction

- Arc Flash
  - Arc flash is a sudden release of heat and energy caused by an electric arc.
  - The result of the violent event can cause destruction of equipment, fire, and injury not only to the worker but also to nearby people.

Introduction

- Arc Flash
  - 3-phase Arc in the Open Air



Risk Category

- Risk Category

Risk Category	Maximum cal/cm^2	Clothing Requirement
0	[<1.2]	Natural fabric, 4.5+ oz/yd^2
1	4	FR shirt/pants or FR coverall
2	8	FR shirt/pants or FR coverall
3	25	FR shirt/pants or FR coverall & flash suit
4	40	FR shirt/pants or FR coverall & flash suit

0 – 4 Safety glasses/goggles, Hearing protection

1 – 4 Hard hat, Leather gloves, Face shield/flash suit hood

2 – 4 Leather shoes

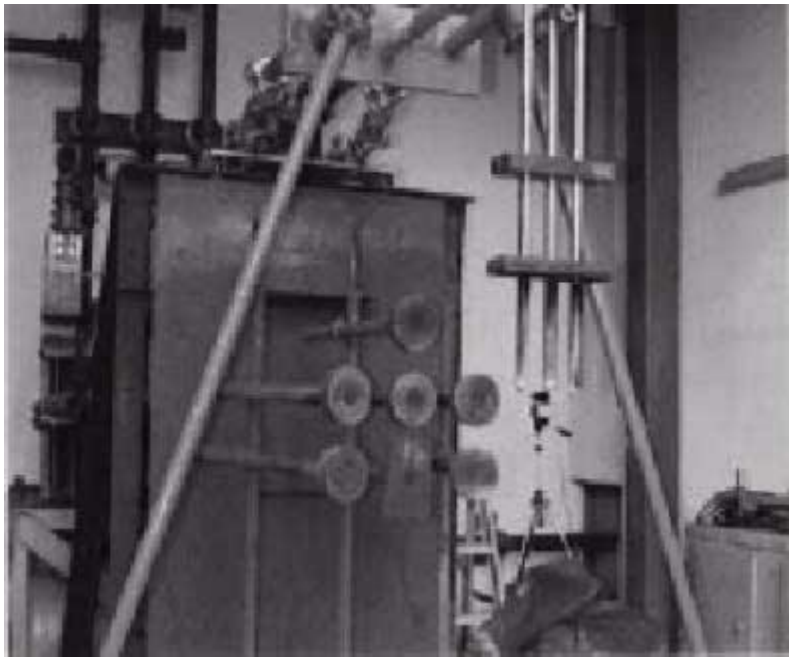
Personal Protection Equipment

- Risk Category
  - Sample PPE

Source: http://GraphicProducts.com

IEEE 1584-2002

- Available Configurations

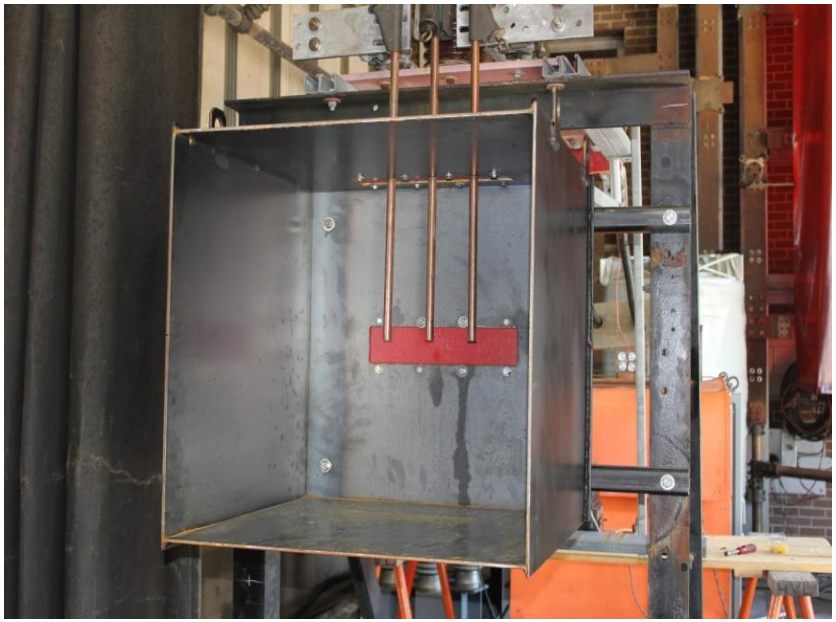


Source: IEEE Std. 1584-2002

Important Factors to be Considered

- Bolted fault current level.
- Duration of the arc.
- Voltage level.
- Electrode Orientation/Configuration (VCB, VCB-Barrier, HCB, VOA, HOA).
- Gap width between electrodes.
- Calorimeter arrangement and measurement locations.
- Distance between electrode and back panel*.
- Dimensions of the metal enclosure**.

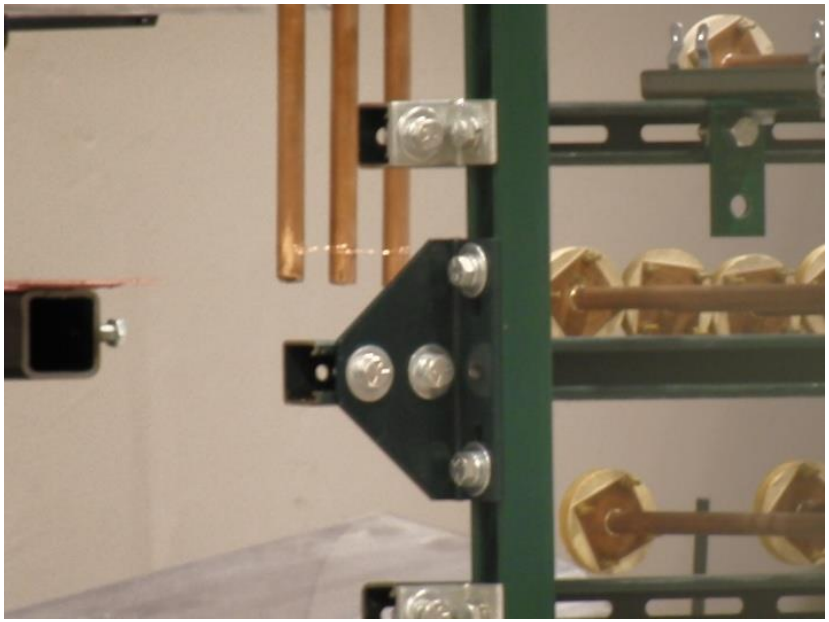
Available Configurations for the Proposed New Model



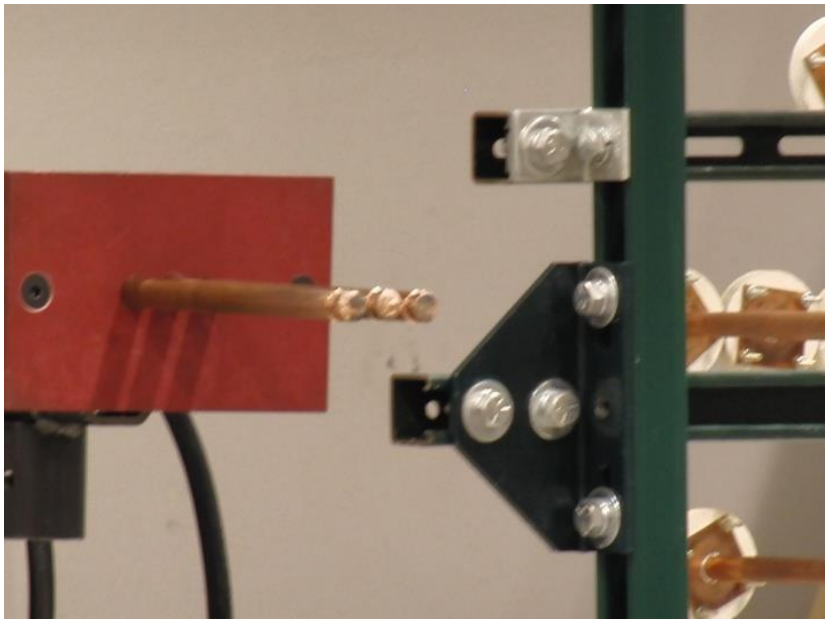
Vertical Electrodes in the Cubic Box
Electrodes are Terminated in the Middle of the Box
(VCB)

Vertical Electrodes in the Cubic Box
Electrodes are Terminated at the Bottom of the Box
(VCBB)

Available Configurations for the Proposed New Model



Vertical Electrodes in the Open Air (VOA)



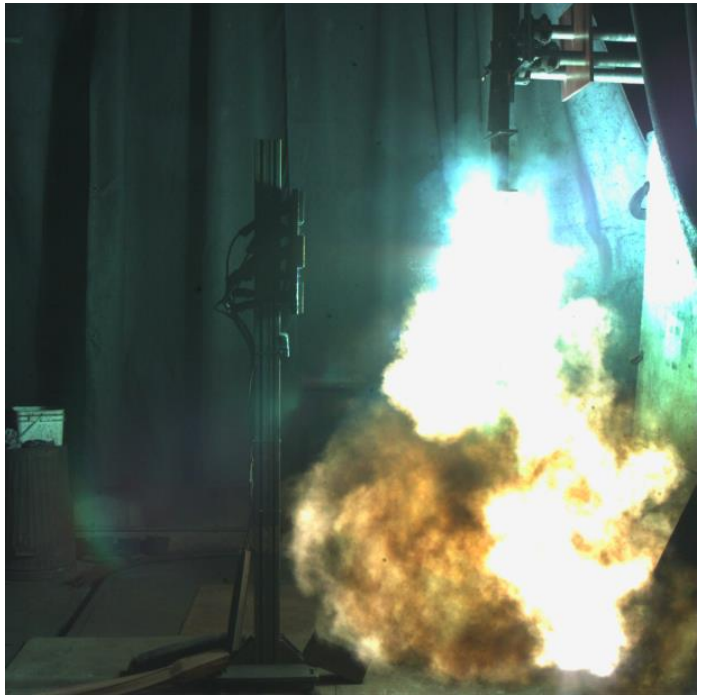
Horizontal Electrodes in the Open Air (HOA)

Available Configurations for the Proposed New Model

Horizontal Electrodes in the Cubic Box (HCB)

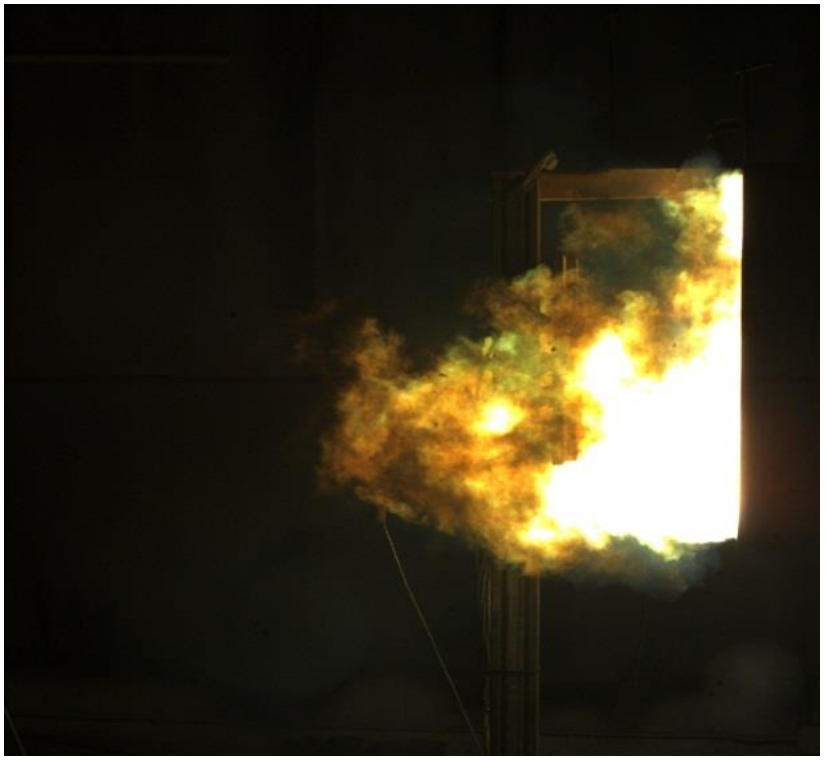
Observation from the Testing

- Plasma Trajectories for Horizontal (HOA) and Vertical (VOA) Configurations

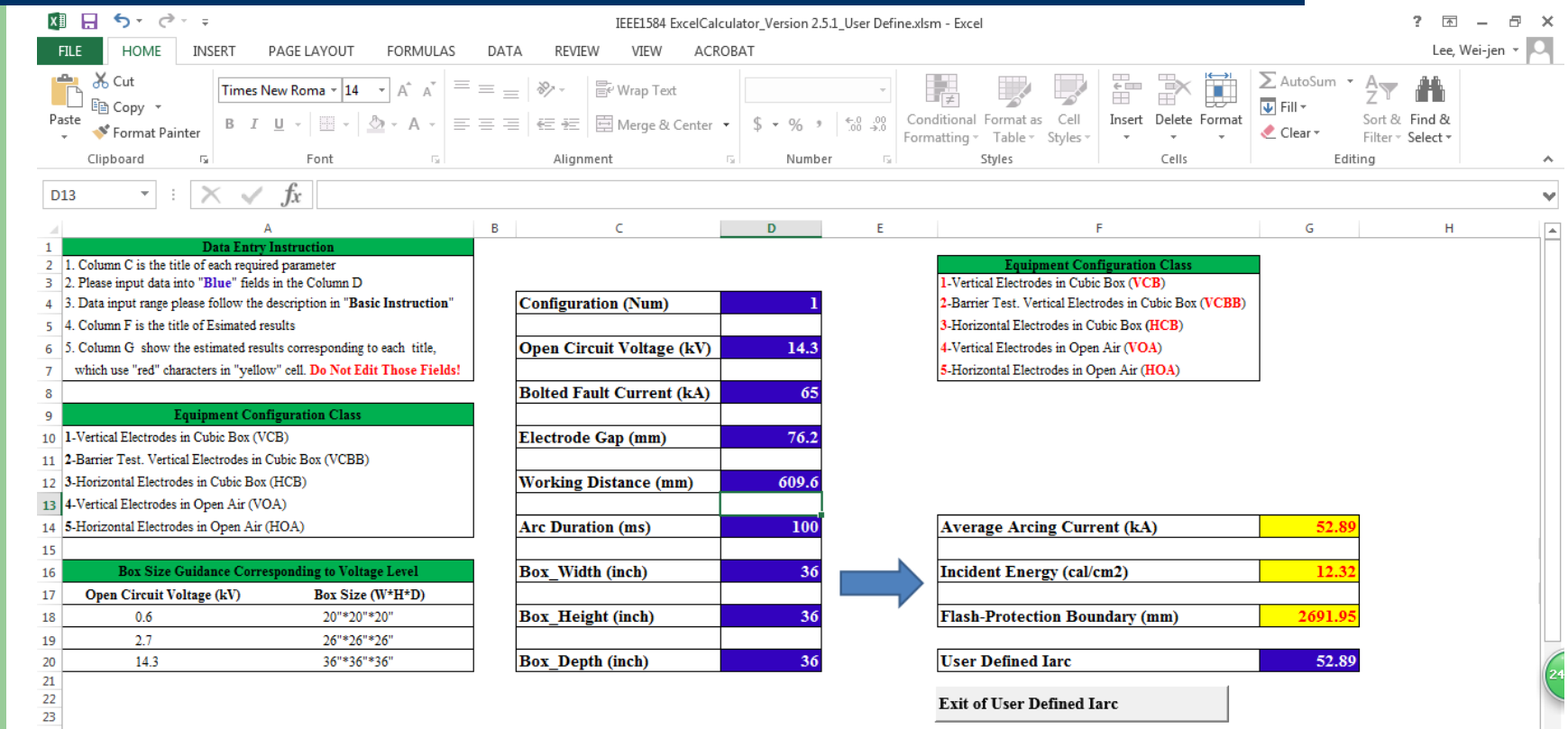


Observation from the Testing

- Plasma Trajectory for Vertical (VCBB) Configuration



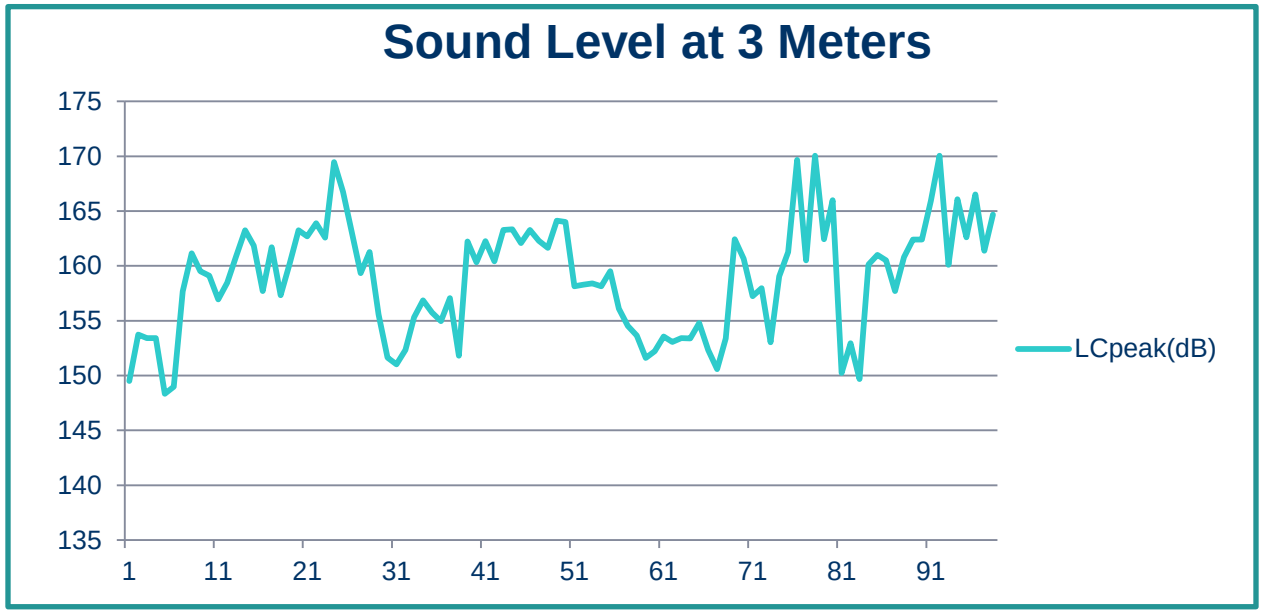
Newly Developed Iarc, IE, Arc Flash Protection Boundary Calculator



Non-Thermal Related Hazards

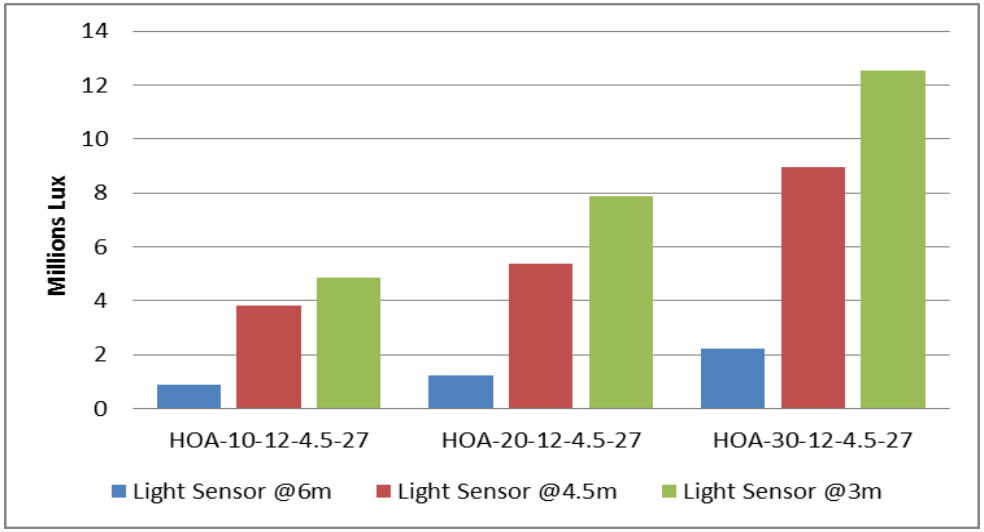
Sound

- Peak Sound Pressures for Medium-Voltage (2700V) Testing Series.
- Hearing protection should be included as part of PPE.



Light

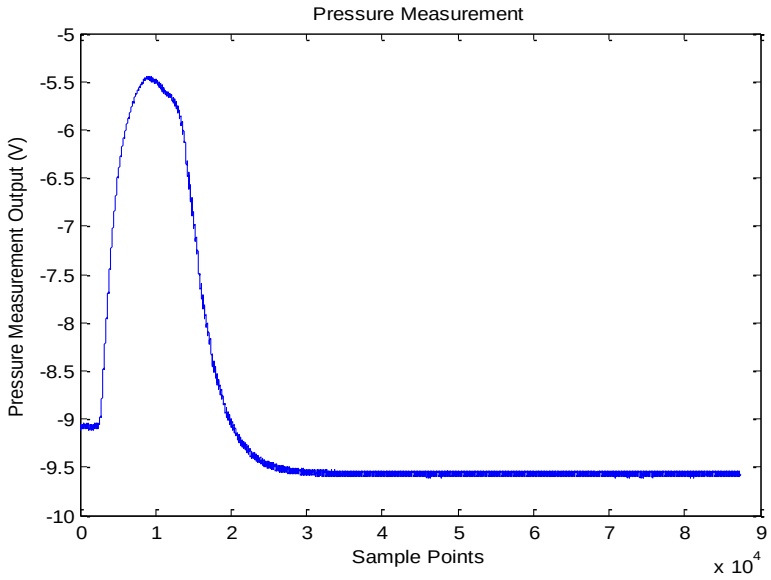
- Recorded light intensity level in lux at 3m, 4.5m and 6m from the arcing point.



Typical bright sunlight is around 110K lux

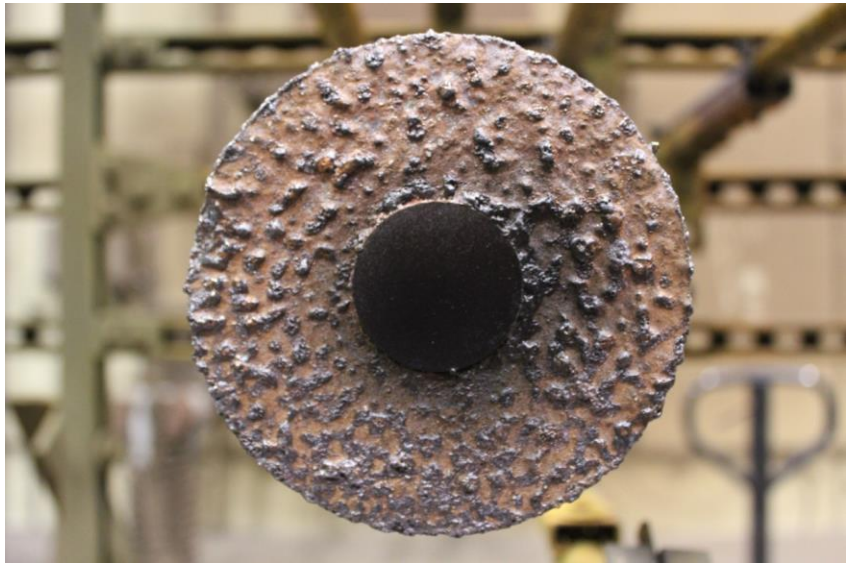
Pressure

- Sample results of pressure measurement
  - The estimated pressure reached 0.715 psi (103 lbs/ft^2) at the working distance of 18”



Something That Calorimeter Can Not Measure

- Face Shield is Recommended for Environment that Arc Flash May Happen



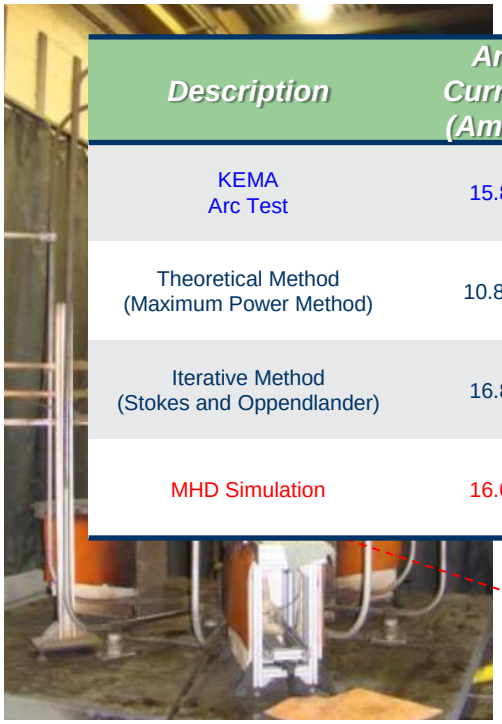
Copper on the surface of the insulation Board of the calorimeter

Lens was damaged by the melted copper.
(10 feet from the arc point)

Simulation of DC Arc Flash

DC Arc Flash Simulation

- System Voltage: 480V, Bolted Faulted Current: 21744A, Gap: 25.4mm



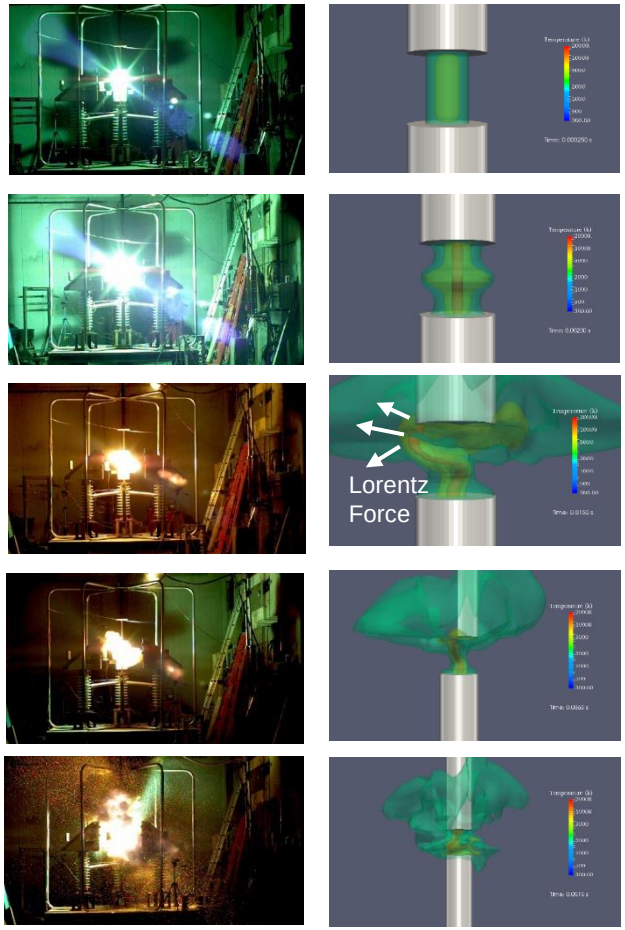
Electrode

Description	Arc Current (Amps)	Arc Voltage (Volts)	Arc Power (kW)
KEMA Arc Test	15.81	131	2.071
Theoretical Method (Maximum Power Method)	10.872	240	2.609
Iterative Method (Stokes and Oppendlander)	16.89	107.25	1.811
MHD Simulation	16.00	126.76	2.028

Gap

Electrode

Faraday Cage Arc Flash Test



480V, 20kA, 1” Gap Arc Flash Test

Thank You !!!